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Forthcoming Events.

MAY 19 to 21.
Institute of Transport:—Congress at Birmingham.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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"Safety First," by Law.

At the recent annual meeting of the "Safety First" Association the Home Secretary foreshadowed the possibility of legal provision of safety officers in the larger factories. This has been followed up by a letter to the various employers' federations stating that he has provisionally approved the issue of an order requiring the institution of special safety arrangements in the principal accident-producing sections.

This circular points out that the development of safety arrangements in factories is making but poor progress, the total number of accidents being reported annually showing no sign of substantial reduction. About 40 per cent. of these are due to preventable causes, such as the non-provision of fencing, whilst the balance are ascribable to causes not so far touched upon in the Regulations. Naturally recourse is made to what has become to be known as the Safety-First system, and figures are quoted showing the valuable work done by organisations where these are in force. A request is made for the various employers' federations to submit observations, and, if possible, to take the necessary steps voluntarily on the lines set out in the proposed order. If this were done then the proposed order would be postponed so far as that particular industry is concerned. The Order applies to iron foundries in which more than 50 persons are employed.

Whilst we have every sympathy with any humanitarian proposals, it is essential that these matters are kept within their proper perspective. Primarily, it is stated that Safety First is a paying business proposition, and as it has been in vogue sufficiently long, authoritative figures ought to be available. Again, we trust those advising the Home Office have not been too strongly influenced by American practice, as the heterogeneity of the labour available for that country's industry makes for conditions which are in no way comparable with British.

Regarded from a national point of view, we estimate that about 1,000 of these officers will have to be appointed, and we trust that sufficient elasticity will be allowed so that the major portion of the time of any of these persons, except perhaps in the largest establishments, may be spent in either production or supervision of production. We are of opinion that, so far as foundries are concerned, a thorough understanding and application of the matter contained in the papers, which Messrs. Bartlett, Patman and Morgan have written, by the foreman in charge, supplemented by monthly meetings with the manager, works engineer, charge hands and shop stewards, would be quite as effective as a full-time officer. This latter individual after a few months would probably suffer from the same type of mental atrophy in respect to ever-present dangers as does the workman who so regularly and nonchalantly risks them.

Those responsible for "Safety-First" propaganda have, especially in America, indulged far too much in "sob-stuff" posters, calculated to appeal to the mentality of an eight-year-old lad. The object of these efforts is apparently to inculcate in the mind of the workman a constant fear of accidents. This is not the best "frame of mind" for any man to be saddled with, and may defeat its own object by breeding a state of nervousness. Rather do we believe in an ordered system of work so as to make matters fool-proof. We suggest, with all respect to the Home Office, that there is in British factory life an inherent sense of "Safety First" which merely requires a red-tape-free direction.

Large Research Department Inspected.

On April 30, members of the London Junior Section of the Institute of British Foundrymen spent an interesting afternoon in the Research Laboratories of the General Electric Company, Limited, at Wembley.

The visitors were shown round by Messrs. S. V. Williams and T. M. C. Lance, who carefully explained the many modern devices with which these laboratories are fitted. The building has a frontage of 400 ft. and a total area of 80,000 sq. ft. occupying an enclosure of four acres. There is one long block running east and west, with centre and west wings running north, a two storey central extension to the south housing the administration section.

A central corridor runs the whole length of the main block and the wings, and above it is a gallery along which all supply service lines are carried. In this way it becomes simple to convey any of the supplies (gas, vacuum, compressed air and electricity) to the individual laboratories through permanent openings provided in the walls of the gallery. The electrical supplies are not centralised, but are brought from the galleries to the rooms via distribution boards placed in convenient recesses in the main corridor. These boards are so arranged that any available electrical supply can be readily switched through to any of the rooms.

There are nine small groups of rooms built out as private offices from the main laboratories and arranged so that there is direct access from every laboratory to one or another of the groups of offices. Each research man thus has a personal sanctum near to his experimental work.

General Equipment.

The general equipment comprises in the first place the necessary plant for the supply services. This plant is mainly housed in a central sub-station, and includes vacuum pumps, air compressors, and the electrical machinery and main switchboard. As already stated, the experimental electrical supplies to the laboratories are mostly provided for by special distribution boards. There are, however, two ring mains with plugs in all the rooms, giving 110 volts A.C. and D.C. In addition, there are special permanent supplies for fixed installation, such as lamp and valve life test.

Experimental Equipment.

In the laboratories, provision has been made for laboratory experimental work, development work, and routine testing of certain products. The first two of these tend to overlap, but to allow of the fullest scope for development work there are four laboratory factories, dealing respectively with tungsten wire, lamps, thermionic valves and primary batteries. These allow of the manufacturing processes being studied by the research staff in greater detail than would be possible in the main works of the Company; while conditions can be varied as required without fear of disturbing production.

Routine Testing.

The life testing of lamps and valves is carried out on a large scale, elaborate installations having been provided for the purpose. These tests are carried out both to provide the factories with independent data on the behaviour of their products and also so that the results obtained may be applied by the research staff in the laboratories to the elucidation of manufacturing problems.

Metallurgical Work in the Laboratories.

The study of the behaviour of tungsten is, of course, of great importance in the manufacture of lamps and valves. Much work is done in the laboratories in this connection. There is a well-equipped metallographic laboratory, which includes a special photomicrographic camera constructed in the laboratory workshops. The work on tungsten is, of course, greatly assisted by the existence of the experimental tungsten wire factory. Work is also carried out on refractories (especially in connection with glass manufacture), and on such metallurgical problems as resistance alloys for electrical heaters, nickel-iron alloys for glass-to-metal joints in large valves, chromium plating, etc.

Workshops.

There are large metal and wood working shops in the laboratories. These have a dual function; firstly, to make up for the research staff such special apparatus as may be needed in connection with researches and the general equipment of the laboratory; secondly, to undertake problems of their own which may, or may not, be regarded strictly as research work, but which are, nevertheless, of great help to the factory and to the applications of research to production processes. This work consists of the study of manufacturing processes, particularly those which are, or might be, carried out by automatic machinery and the devising of machinery for increasing the speed or the uniformity of production.

The visitors were entertained to tea by the Company, after which a hearty vote of thanks, proposed by Mr. P. Ellis and supported by Mr. V. C. Faulkner, was passed to Messrs. the General Electric Company, Limited, for throwing open their laboratories and for their kind hospitality.

Foundry Examinations.

If a register of the number of classes on foundry practice could be assembled, we believe it would be so long as to be something of a revelation to the average foundry owner. If these matters could be further analysed, it would be found that moulders as students do not predominate, but patternmakers. The examination paper set by the authorities at the Sir John Cass Technical Institute is reprinted below, as it is so comprehensive that it may serve as a useful pointer to the dozens of other classes being held throughout the country.

Examination in Foundry Practice.

(*FIVE questions only to be attempted, of which No. 4 must be one.*)

1. State the essential properties of moulding sands and show how these properties may be improved by mechanical treatment. What property or properties you mention would influence the selection of a suitable sand for castings in (*a*) steel, (*b*) aluminium, (*c*) phosphor bronze?

2. Sketch and describe in detail a pair of moulding boxes, giving typical dimensions of every part.

What do you understand by the term "oddside moulding"? State the materials suitable for the manufacture of oddsides, giving their advantages and disadvantages.

3. Describe in detail, with the aid of sketches, a modern foundry cupola prepared for working. What refractories may be used for lining the cupola? Give their approximate compositions and state which constituents are undesirable and why.

4. What mixtures would you choose for the following castings: (*a*) Hydraulic cylinders, (*b*) small pulleys for shafting, (*c*) fire-bars, (*d*) malleable castings? Give reasons for your choice.

Give the approximate composition of (*d*) and state what changes take place in the structure of a malleable casting during the process of malleablising.

5. What is the difference between a "densener" and a "chill"? State the conditions under which these would be used, and illustrate by sketches their application in foundry practice.

6. Enumerate the causes of bad castings in the foundry, and show how these may be eliminated.

What do you understand by the term "tin-sweat"? How may it be prevented?

7. What do you understand by the term "flux"? Illustrate your explanation by examples in regard to the founding of cast iron, gunmetal, aluminium alloys.

In connection with this particular examination, the student gaining the highest number of marks receives the Wesley Lambert prize.

Blakewater Foundry, Limited.—Capital £5,000 in £1 shares, to acquire business carried on by John Lang & Sons (Blackburn), Limited, Blakewater Foundry, Blackburn. Secretary: T. A. Aspden.

Pattern Dowel Pins.

By Ben Shaw.

The turned or planed pin has retained its place in many pattern shops. They are very handy for delicate ribs inside a core-box, or even for very small work. Wooden dowels should be tightly driven, but the projecting or fitting part should be a very good fit, tapered practically all its length, and where the work is comparatively small the dowel ought to go right through one half, so that they can be driven back to allow of the joint being planed. It is a mistake to use too small dowels in work, and especially in large work they cannot be too large. It can be readily seen that in handling a large pattern small dowels soon get broken or worn, and in the joint plates of large patterns 1-in. or 1¼-in. wooden dowels are not too large and they need not project more than ¾ in. It is foolish to have a long-fitting piece. A very wise precaution in patterns that are symmetrically designed is to fit two dowels of different sizes, so that the moulder cannot carelessly reverse the top half of the pattern.

For making dowels ash is hard, but it is tough. Baywood is not hard enough; teak is much better. Soft woods ought never to be used.

The objection to brass screw dowels is that they are too easily removed. Their very hardness in fitting is their disadvantage. Anyone who has used them knows how a slight mistake in boring causes a tightness, which can be remedied by a tap on the outside when the two halves are together. A similar tap in the foundry—and patterns are sometimes dropped there—would cause an inaccuracy. In well-seasoned hard wood, where both the dowels and the sockets are well fitted, there is not as much danger, and, of course, they have the great advantage over wood that they stand a lot of usage before wearing. It takes some practice to fit brass socket dowels properly. If the sockets are loose they are useless, but if they are driven into too small a hole they may cause the pattern to split ultimately, even if it does not do so when being made.

Iron Dowel Plates Advocated.

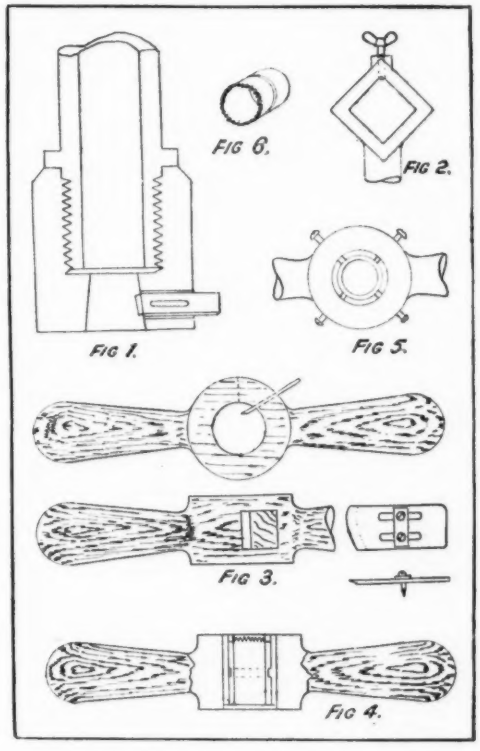
All things considered, iron plate dowels are the best kind obtainable. There is no danger of splitting, and if the plates are not set much below the surface they fit just comfortably. They compare with wooden dowels in that they can be temporarily removed to plane joints. However, they cannot be used on very small work. The trouble with them is that the special centres get broken or lost, but this, of course, is a matter for the shop foreman. The best job is undoubtedly obtained by planing the recess bored by the centre bit with a router, so that the plate lies on a level surface. There is practically no end to the life of iron plate dowels.

Where it can be done, as in the case of circular built work, where, for example, there is a loose flange, or where the pattern must be jointed in two or more sections, a turned dowel neatly fitted makes a really fine job. Even if the pattern is made of pine the dowel should be of hard wood, and built if possible, as otherwise the dowel may become slack or tight across the grain owing to shrinkage or swelling. A ½-in. dowel is sufficiently long. When this method of dowelling circular patterns or core-boxes is adopted, it makes a better finish to turn the actual faces of the work at the same time, that is, when all the joints have been made. To prevent one half of the work from revolving on the other a small dowel may be fitted.

In large shops where much dowel pin may be required for different purposes, a special device can be made for its manufacture. A lathe with a hollow chuck is necessary and a special chuck has to be made similar to Fig. 1. It is best to make it from a piece of steel, or a pattern may be made and a casting in iron obtained from it, and then have it machined to suit the lathe spindle. Have a part of the chuck cut away so that a cutter may be introduced, as indicated in the sketch. This cutter should be set at an angle so that when it is revolving it will catch the material passing through the central hole at a tangent, the idea being to secure the action which takes place when operating a turning chisel by hand—that is, a true cutting action and not a scraping cut. The recess in the chuck should be large enough to allow adjustment of the cutter to vary the size of the cut.

Square the material to be used for the dowels on the dimension saw, making them just full of the finished size of the dowels. Cut the sharp corners off one end of each piece in order to give them a start, and feed each one separately into the chuck. It is necessary to have some attachment on the lathe bed through which the pieces will pass to prevent the wood turning round with the lathe.

Such an attachment as shown in Fig. 2 will suffice, providing the spindle is screwed into a base piece to slide on the lathe bed so that its height can be adjusted. The thumb screw enables the wood being fixed in the carrier, and the whole can be pushed along as the wood is being fed into the cutter. When adopting this method it is advisable to have an attachment at the other end of the head-stock having a cone-shaped hole to assist the dowels in coming out straight. This method is advantageous in that it can be used any time the lathe is not in use for other purposes, and the maintenance of the stock of varying sized dowels



can be left in the hands of a boy. It is not all lathes, however, which possess a hollow spindle, but a similar principle can be adopted, with this difference, that the wood revolves instead of the cutter.

A wood tool holder can be made as shown in Fig. 3. It is, of course, necessary to use a hard piece of wood for this purpose. It will be observed that the cutter is slotted in two places so that all the responsibility of holding the cutter is not placed on one screw. The sketch shows the bearance for the cutter made flat and parallel with the axis of the wood to be cut, but having the tool edge shaped, the bearance can, however, be cut on the skew. The holder can be made to enable an adjustment of ¼ in. in the diameter; it is better to make another tool holder than to attempt more. The material to be converted into dowels is prepared in a similar manner to that already described, and one end of each piece reduced as before. A chuck is screwed to the lathe having a tapered square hole about its centre, into which the pieces of wood are located separately and rotated. Then, by moving the holder containing the cutter towards the headstock, and with the wood passing through the central hole, a circular

dowel will be formed. Any slight adjustment of the cutter may be made after the first dowel has been made in order to get an accurate size.

Another reliable method is shown in Fig. 4, which illustrates the use of a circular cutter. It is necessary to have a separate cutter for every size of dowel desired, but they are comparatively easy to make, and once made will last a long time with only an occasional touch up with a file.

The type of cutter is shown in Fig. 6. A saw edge is filed about one end and a recess is cut out of the steel tubing, as illustrated, to form a check into which set-screw penetrates through the wood holder. This method allows a series of different sized cutters to be secured in the one holder.

The position of the cutter in the holder is shown in Fig. 5. Sometimes these circular cutters have the central bore tapered to release the dowel as it passes through, and it is an advantage to do so. The cutters are, however, sharpened from the outside, and a slight burr is formed, which makes a dowel slightly smaller than the bore of the tubing. This point should be taken into consideration when making the cutter for a definite-sized dowel. A similar type of cutter can be used equally as well in the chuck attached to the lathe, as previously described. Any of these methods of preparing dowels can be safely left to boys, and with very little experience will compare favourably in accuracy and usefulness with other methods, and when a moderate supply of varying sizes is required a stock can be maintained at low cost.

Enamelling of Cast Iron.

By Fearnley Allen.

The present method adopted for the enamelling of articles of cast iron, such as baths, stove work, electric fittings, etc., is commonly known as the dry process, the article to be treated having to be brought to a high temperature in a furnace heated to between 800 and 1,000 deg. C., withdrawn, and the enamel in a dry state being dusted on and then replaced in the furnace for about eight minutes to enable the enamel to fuse and flow. Whilst it is possible to obtain an appearance which, at first at any rate, may be good, there are certain points in this process which leave a great deal to be desired, and which, if they could be improved on, would undoubtedly not only produce a better and cheaper article, but would certainly create a much larger demand for enamelled goods.

It will be well to enumerate some of the points which will readily be acknowledged by those using the present process:—

(1) The high furnace costs, both initial and running.

(2) The limited output, owing to the fact that each article has to be enamelled and fused separately.

(3) The excessive heat produced by the article when removed from the furnace, combined with the inhaling of the fumes produced, causes great inconvenience and even danger to the health of the operator.

(4) The operation of dusting on the enamel has to be carried out by a more or less skilled hand.

(5) The difficulty of satisfactorily treating castings where the cross section changes suddenly, the enamel frequently cracking at this point owing to its not being able to accommodate itself to the uneven expansion and contraction of the metal.

(6) The fact that concentrated heat on a finished article will cause the enamel to break up or blister.

Recently a process, namely, the ferro wet process, comparatively new to this country, but for some time past extensively used in the United States, has been introduced here, and in certain works where it has been installed for about three years it has proved definitely successful, both in the matter of cost and also as regards the excellent finish obtained.

At the Industries Fair held at Birmingham certain firms had some cooking stoves and electric heaters which had been treated by the new process, and the interest taken in these exhibits was very marked, especially when it was pointed out that the enamelled portion could be subjected to the ordinary working heat without showing any sign whatsoever of cracking up, the result being that certain firms decided to install the necessary plant at their works, recognising that the public would certainly soon create the demand once the advantages were known.

It will be interesting to go over the points that have been previously mentioned as being disadvantages now met with in the present-day dry process, and see to what degree they are claimed to be overcome by the new or wet process.

Instead of the furnace being raised to a temperature of about 1,000 deg. C., the fusing temperature averages 715 deg. C., thus obviating the warping of castings and sheets and thereby increasing the life of the furnace. It is clear, therefore, that the saving in fuel costs is bound to be very appreciable; it is estimated at 35 per cent. Crude oil is the fuel recommended.

The enamel is sprayed on to the cold metal in a moist state by means of a special spray gun. The articles are then placed on a carriage, which is fitted with a number of trays, and left in a drying room for about twenty minutes. The castings are then placed on special fixtures and loaded into the furnace by means of a loading fork for fusing, the average period of this operation being from eight to ten minutes, when they are finally withdrawn. It must be noted that the furnace is kept fully loaded even to the extent of double or treble decking of the castings, and consequently the claim that the total output can be raised by as much as 40 per cent. seems to be quite capable of attainment.

The preceding paragraph shows that all the enamelling operations are carried out before the articles are put into the furnace, and therefore under satisfactory conditions.

The spraying can be and is carried out by youths or girls, and as the article is held or placed inside a specially constructed booth, all the spray in suspense is drawn away from the operator by means of an exhaust fan.

The surface of the casting at the change of section can be easily treated when spraying and sand-blasting, and the enamel is so deposited that when the work is heated it sets so that no sign whatsoever is seen of any cleavage.

Enamel will not burn or discolour on gas stove burners, grids, cornices, well fire fronts, grate and other castings that come in contact with house heating.

Over and above the points already mentioned this process has certain other outstanding advantages. Where it is necessary to leave surfaces for machining or for any screwed parts, and consequently where an enamelled surface is not required, it is a simple operation to clean the enamel off after the drying process by means of a brush.

Any number of coloured enamels can be applied to the same casting and fused at one burning, whilst perfect reproduction of any timber, marble or stone can be obtained.

Castings treated by this process can be subjected to extremely rough usage without showing any ill-effects. For instance, the enamel will stand repeated blows from a hammer without chipping, and steel plates can be bent without causing the enamel to crack.

As a lead-free enamel has been produced for cast iron as well as sheets, this process can safely be used for kitchen utensils.

This interesting process is in the hands of the Ferro Enamelling Company, of 2100 B.F., Keith Buildings, Cleveland, Ohio, U.S.A., whose British technical representative is Mr. W. Marshall, 188, Bushbury Road, Heath Town, Wolverhampton.

B.S. Specifications for Concentric Piston Rings, etc., for Automobiles.—The British Engineering Standards Association has issued revised editions of the following three Specifications for automobile parts:—No. 5.003, 1927 Wide-Type Concentric Piston Rings; No. 5,004, Cast-Iron Piston Ring Pots, and No. 5,023, Narrow-Type Concentric Piston Rings. Copies of these may be obtained from the Publications Department, British Engineering Standards Association, 28, Victoria Street, London, S.W.1. Price 2s. 2d. each, post free.

The Heat Treatment of Grey Cast Iron and Semi-Steel.*

By O. W. Potter.

(*Continued from page* 374.)

Hardness.

The Brinell and Scleroscope hardness tests follow in general the indications shown by both the transverse and tensile strength; the softer the material, the weaker. The effect of the heat treatment on all of the specimens was substantially the same, with the exception of heat treatment No. 6. This large variation in No. 6 is no doubt due to the difficulty of giving each bar exactly the same treatment. It was rather difficult to control the quenching temperature, the temperature of the quenching water and other conditions of manipulations. The long anneals, Nos. 4 and 9a, gave the most uniform results which would be expected since there was no variation in the treatment of the specimens as was the case with other tests.

It is interesting to note the range of variations in hardness from 22 to 62 Scleroscope or 100 to over 300 Brinell. This indicates that almost any degree of hardness, from that of pure iron to that of cementite, is obtainable by a proper heat treatment.

The hardness of specimens of the same material under the same treatment corresponds very closely, which leads us to believe that uniform results can be obtained by a specific heat-treatment.

Impact Tests.

The broken specimens from the transverse test of small bars were tested in impact without notching on an American Charpy impact machine. These were taken to ascertain the comparative toughness with and without heat treatment. Cast iron is usually considered as a brittle material, but a knowledge of its resistance to shock is an essential and important factor in the proper use of the material. Some of the important conclusions from this test are:

(1) Most forms of heat treatment improve toughness, and (2) heat treatment No. 5 (heating to 871 deg. C.) holding for two hours and air cooling gave the best impact values.

Machinability Tests.

It was quite desirable that some sort of indication of machinability be obtained. Since no abrasion testing apparatus was available an ordinary power hack-saw was used. The feed was removed and cutting was done under the weight of the saw frame itself. For standardisation, a bar of hot-rolled soft steel was used. A new blade was used for each set of specimens, first cutting the standard steel bar and then the three samples of any group. The time to cut through a 0.80 in. diameter sample was recorded by a stop watch in seconds.

It is to be noted from these results—(1) The wide range of time which was required to saw the bars (some bars were too hard to saw with the blades used). (2) Specimens subjected to heat treatment No. 5 (heated to 871 deg. C.), held for two hours and air cooled), machined almost as easily as the softest specimens. (3) The specimens under heat treatment No. 6 (quenched and reheated to 315 deg. C.) were almost impossible to machine; all samples spoiling a new saw blade with the exception of the P series in which two specimens were cut through before failure of the blade, and (4) annealing at high temperature tended to produce a uniform hardness regardless of the kind of material and original hardness.

Thermal Analysis.

Thermal analysis was made on four specimens which varied considerably in chemical analysis. Time was recorded for equal advances in temperature giving the inverse-rate type of cooling and heating curves. The recording apparatus on the Hump electric furnace used in the last series of experiments gave the average critical for the six different materials used at about 787 deg. C. The critical range for cast irons corresponds very closely to that of steels of corresponding combined-carbon contents. The effect of the other elements is to vary somewhat this range, but the elements producing the most effect are silicon and manganese.

Microscopic Examination.

The microscopic study was made to aid in the determination of the causes for the variation in the physical properties. A complete set of micrographs for each heat treatment of sample A are shown in Figs. 1-18. It was apparent that there was no appreciable change in graphite flakes when annealed at 260 deg. C., 538 deg. C., and 734 deg. C. (below the critical point). At 734 deg. C., however, when etched in picric acid, there is a breaking up of the laminar pearlite to granular pearlite, and there is quite an apparent migration of the carbon particles towards the larger graphite flakes.

The light areas appearing in relief on the unetched micrographs are very likely phosphide eutectic (steadite). These seemed to encircle the original grain boundaries of the primary austenite. This was quite visible when etched with 10 per cent. nitric acid and viewed at 50 magnification. The phosphide being the last thing to solidify, it is at the grain boundaries as would be anticipated. Since the austenite grains change to pearlite in the process of cooling their boundaries are no longer visible, only as indicated by the network structure of the eutectic steadite as shown in micrograph. (Fig. 19.)

Specimens heated above the critical point show larger graphitic flakes as shown in micrographs. (Figs. 5 and 7.) On slow cooling the carbon migrates to the graphite flakes, leaving a solid solution background of ferrite and silicon. (Fig. 6.) On air cooling, the migration of the graphite is retarded, the region next to the graphite flakes alone being affected. The amount of migration seems to be proportional to the rate of air cooling, and under proper conditions might be practically eliminated. This would give a maximum strength with minimum hardness. The physical tests appear to substantiate these conclusions.

Quenching from above the critical point in either water or oil gives a martensitic matrix. Sample A7 at 1,000 diameters (Fig. 12) when heated to 871 deg. C., water-quenched and reheated to 538 deg. C., showed a sorbitic matrix, whilst A8 (Fig. 14) showed only a small amount of granular pearlite with a solid solution matrix. It is also apparent in the relief polished specimens that the graphite flakes are larger and that some temper carbon is also present.

Annealing above the critical point followed by quenching from above the critical gives a very characteristic martensite. This material was exceedingly hard and brittle, and had to be reannealed before samples could be machined. This reannealing resulted in a granular pearlitic matrix. There was considerable temper carbon present also. (See Figs. 15 to 18.)

Quenching from extremely high temperatures seems to cause a spherodising of the graphite, as shown in Figs. 20 and 21. Specimens which were annealed at very high temperatures or allowed to cool slowly showed a background matrix which seemed to be ferrite. Upon etching in hot sodium picrate it was discovered that only the narrow strips around the graphite flakes could be regarded as pure ferrite. (Fig. 22.) Otherwise the main background matrix material must then be a solid solution. Since there is considerable silicon present in all cast irons it is very likely in solution with the ferrite. This background matrix is probably a solid solution of silicon, carbon, and phosphorus in ferrite. It might

* Abstract from the annual Exchange Paper presented on behalf of the American Foundrymen's Association to the Brussels Congress of Association Technique de Fonderie de Belgique, Mr. Paul Ropsy presiding.

Fig. 13.—Sample A8.—Heated to 870 deg. C. Water Quenched and drawn at 704 deg. C. Relief Polished × 100.

Fig. 14.—Sample A8.—Heated to 870 deg. C. Water Quenched, and drawn at 740 deg. C. Etched with Picric Acid × 500.

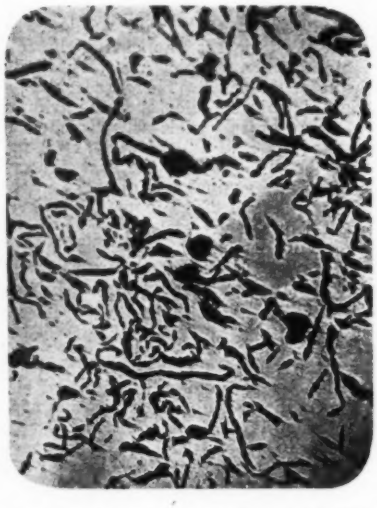


Fig. 15.—Sample A9a.—Heated to 1,600 deg. C., held for three hours, and Air-cooled. Re-heated to 870 deg. C., and Water Quenched. Relief Polished × 100.

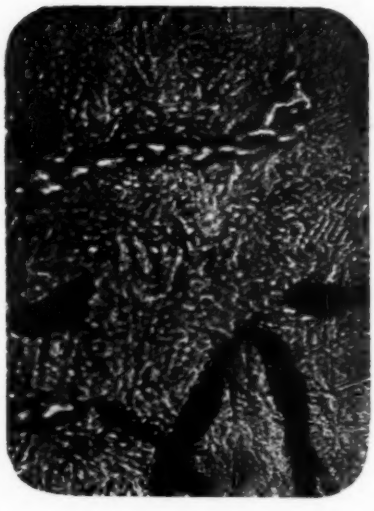


Fig. 16.—Sample A9a.—Heated to 870 deg. C. Held for three hours, and Air-cooled. Re-heated to 870 deg. C., and Water Quenched. Etched with Picric Acid × 1,000.

Fig. 17.—Sample A9.—Same Treatment as for 9a, and then Re-annealed at 870 deg. C. Relief Polished × 100.

Fig. 18.—Sample A9.—Same Treatment as for 9a, and then Re-annealed at 870 deg. C. Etched with Picric Acid × 500.

Fig. 19.—Sample P.—Etched with HNO_3. Network Structure of Phosphorus Eutectic Steadite × 50.

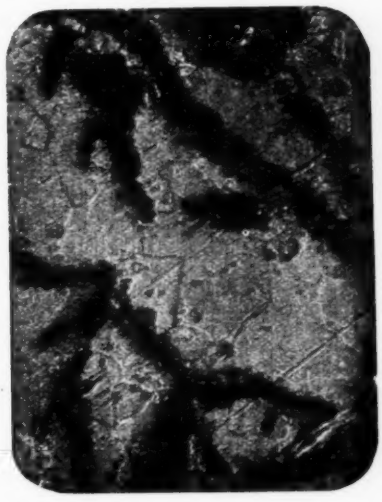


Fig. 20.—Sample C1.—Etched with Picric Acid, Annealed at 870 deg. C., with Slow Cooling; Re-heated to 910 deg. C.; Water Quenched × 500.

Fig. 21.—Sample C1.—Etched with Picric Acid, Annealed at 870 deg. C., with Slow Cooling; Re-heated to 909 deg. C. Oil Quenched × 500.

Fig. 22.—Sample SS.—Etched with Hot Sodium Picrate. Water Quenched from below critical point × 1,000.

Fig. 23.—Sample P.—Relief Polished × 100.

Fig. 24.—Sample P.—Etched with Picric Acid × 500.

be a form of austenite, but due to the large amount of silicon present it probably is not to be considered as austenite. This phenomenon also seems to indicate that graphite continues to migrate and is precipitated after the other constituents are established. The same condition was noted on some of the quenched specimens. Along with the above there seems to be a breaking down of the instable phase cementite (Fe_3C).

The high-silicon irons are characteristically different from the low-silicon irons. (Figs. 23 to 26.) There is very noticeably more graphite flakes, more steadite because of high phosphorus, and less pearlite, even in the untreated specimens. This form of the original structure no doubt accounts for the contrary behaviour of the physical properties of the high-silicon irons when subjected to heat-treatment.

The hardening constituents in cast iron are combined-carbon, manganese, phosphorus, and sulphur, the combined-carbon being the most potent. Since silicon is really the controlling agent for the graphitic carbon. The Scleroscope hardness index is not as definite an indication of any characteristic property, while the Brinell tests in all cases seem to give a better relative indication of properties. The Brinell indicates very definitely a softening with increase in total carbon when the silicon content is below 2.00 per cent. This would seem to indicate that silicon above 2.00 per cent. has effects on the hardness other than the precipitation of the graphite.

The Brinell hardness numbers are directly proportional to ultimate strength as in other alloys. The Scleroscope index is usually considered proportional to elastic limit in the steels and non-ferrous alloys. It is known that the elastic limit of cast iron is a variable quantity ranging from almost nothing to near the ultimate strength, depending on the particular constituents present and their physical condition and relation to each other. Hence further investigation may indicate a relationship between the Scleroscope index and some of the other properties of cast iron.

Fig. 25.—Sample P4.—Heated to 870 deg. C., and Cooled Slowly in Furnace. Relief Polished × 100.

Fig. 26.—Sample P4.—Heated to 870 deg. C., and Slowly Cooled in Furnace. Etched with Picric Acid × 500.

Analysis of the Results Obtained.

(1) The strength properties are increased substantially by annealing at temperature below the critical, due to the removal of casting strains.

(2) The heat treatment which gave maximum softness and machinability with the minimum of reduction in strength properties was No. 5 (heated to 871 deg. C., held for two hours, and air-cooled).

(3) The elongation of cast iron in tension is very small. It is increased slightly with anneals above the critical point.

(4) Deformation before rupture is increased by all forms of heat treatment used.

(5) The impact property is improved by heat treatment.

(6) Grey cast iron can be made very hard by water-quenching from above the critical point, and can also be subsequently softened by reannealing.

(7) The strength properties can be almost completely ruined by continued exposure to a high temperature.

(8) The reduction of the strength properties by annealing was not as much with the high-silicon irons as it was with the low-silicon irons. The effects of the heat treatments on the high-silicon irons seemed to vary considerably from those obtained with the lower silicon irons, and in some cases were quite the reverse. However, it appears that it may be possible to obtain certain desired results from heat treatment with less risk of an excessive reduction of the strength properties.

(9) The impact properties of the high-silicon irons were the lowest of the series tested.

(10) The combined carbon is reduced by annealing at any temperature; the higher the temperature the more rapid the breakdown.

(11) The combined carbon content and the hardness can be greatly increased by quenching from above the critical. There is, no doubt, a critical rate of air-cooling which would give maximum strength properties without giving any of the bad effects of a quench.

Report of American Practice.

To make this Paper of as much practical use as possible a questionnaire was sent to a number of the leading grey-iron foundries in the United States in order to get information concerning current practice with reference to the heat treatment of cast irons. A summary of the replies is given below:—

(1) Fifty-nine per cent. of those replying are now heat-treating some of their grey-iron castings; and (2) one per cent. in addition stated that they were in favour of the heat treatment of cast irons, and thought that the trend of practice was in that direction.

The results obtained in commercial practice as reported are as follows:—(1) Uniform hardness; (2) increased machining speeds; (3) less wear on cutting tools; (4) elimination of warpage; (5) relieving of casting strains; and (6) reduction of rejections because of hardness and warpage.

There was a great unanimity in the reports concerning all the above items. Other properties reported as the result of heat-treatment are:—(1) Improved impact properties; (2) better wearing properties; and (3) greater hardness (quenched specimens).

Services of Metallurgy to Engineering.

Some recent services of metallurgy to engineering were reviewed by PROF. H. C. H. CARPENTER in the thirty-third annual James Forrest Lecture, which he delivered at a meeting of the Institution of Civil Engineers in London last week. He recalled that it was 21 years since Sir Robert Hadfield had delivered the last James Forrest Lecture, in which metallurgy constituted the main subject.

Dealing with the progress made since that date, Prof. Carpenter gave a table of the world's production of the six principal metals used in engineering practice in the years 1905 and 1925, from which emerged an interesting point regarding the figures for pig-iron and steel ingots and castings. In 1905 the total pig-iron production exceeded the steel production by 10,000,000 tons, whereas in 1925 it was 11,000,000 tons less. Not all the pig-iron produced in any one year, which was ultimately converted into steel, was refined in the year in question, although probably the bulk of it was so converted, and it was impossible to make a quantitative allowance for this difference. It was permissible to conclude, however, that there was now a markedly greater tendency to use steel in preference to cast iron than there was twenty years ago. Actually, the excess of 11,000,000 tons of steel over the pig-iron production in 1925 must be due mainly to the remelting of steel scrap.

The most striking increase during the twenty years was furnished by aluminium, a newcomer among the non-ferrous metals, which had become one of the world's common metals. In 1905 its production by weight was only one-sixth that of tin; in 1925 it was 50 per cent. more. Moreover, if account be taken of the fact that the specific gravity of tin was 7.3, while that of aluminium was about 2.7, it would be seen that the volume increase was far greater. The challenge of aluminium to the other non-ferrous metals, and indeed to steel, had only begun, but already the placing of this metal in the ranks of the principal industrial metals must be regarded as one of the outstanding metallurgical achievements of the period under review. It was clear that the largely increased production of metals during the period in question must have necessitated the using up of a corresponding largely increased quantity of the ores from which they were produced, and in time this was bound to create a shortage. Any metallurgical discovery, therefore, which rendered available larger supplies of ore minerals by improvements in methods of extraction must certainly be regarded as a service to engineering. It was equally clear that if it were possible to improve the qualities of existing metals and alloys so that less of them was required in any given structure or piece of machinery, this also must rank as a service to engineering. Further, the introduction of a new metal or new alloy, with properties superior to those of existing metals and alloys, constituted a service of a similar kind. Finally, the more perfect preservation of existing metal structures by the development either of new alloys which resisted corrosion more effectively, or the formation of protective films, would be a service whose importance it was hardly possible to overrate. These four aspects of metallurgical service the lecturer dealt with in turn

Discussing the first of these—ore treatment—he reviewed the progress of flotation concentration (applicable principally to zinc, lead, copper and silver), the development of reverberatory practice with special reference to copper, and hydrometallurgy with special reference to copper and zinc.

Electric-Furnace Practice.

Coming to the second aspect—the refining of crude metal—the lecturer dealt first with the electric refining of steel. Twenty years ago, he said, the manufacture of steel in the electric furnace was still in the embryonic stage; to-day, more than 1,200 such furnaces were in operation in Europe and America (including Canada), in about equal numbers in the two Continents. In the decade 1910-20, the advance of electric steel had been phenomenal, production having increased from 52,141 tons in 1910 to 502,152 tons in 1920. In 1925 1,042,000 tons were produced, of which the United States were responsible for 615,000 tons, Italy 129,000 tons, Germany 127,000 tons, France 68,000 tons, and Great Britain 44,000 tons. The principal use of such furnaces had been in producing alloy and tool-steel ingots and castings. The outstanding disadvantage of the electric process was its cost; but it might be expected that, with continual improvement in the efficiency of power production plants, this disadvantage would tend to become less. Another factor which would operate in the same direction would be that economies of furnace operation would be more thoroughly understood and practiced. Another disadvantage from which the furnace had suffered more or less hitherto was that it had been operated by men unfamiliar with its possibilities. To some extent the view had prevailed that electric steel occupied a field mid-way between acid and basic open-hearth steel and crucible steel, but that, of course, was not the case. The quality of electric steel was fully equal to that of crucible steel, and could be achieved provided refining was properly carried out metallurgically. Hot-metal electric furnaces were nearly always operated in conjunction with a large open-hearth plant, in some cases as the final operation of a three-furnace process (Bessemer, open-hearth and electric), commonly known as the triplex process. With proper operation, the product was sufficiently good to have warranted both German and American railways paying a higher figure for steel made by this process. It was important to remember in electric steel-making that desulphurisation did not necessarily guarantee de-oxidation, but that de-oxidation did guarantee de-sulphurisation. With the passage of time a body of younger men was gradually becoming versed in electric steel refining, and it was to be expected that the quality of the resulting metal would be still further improved.

Except for small amounts of manganese sulphide and silicate, electric steel should be free from non-metallic inclusions when melted with restricted or with no oxidation. Even when melted with complete oxidation, if it were deoxidised thoroughly it should still be cleaner than basic open-hearth steel. Steel metallurgists had paid far too little attention to the presence of gas in steel and to its effect on its quality. The amounts of oxygen, hydrogen and nitrogen present in the electric process should be enormously less than in the open-hearth process, and the only gas that should be present in any quantity was carbon monoxide. The presence of this was due to the oxidation of carbon by ferrous oxide, and the amount present would depend upon how far oxidation had been carried. It followed that when heats were melted with complete oxidation there would be more carbon monoxide than when oxidation was restricted, but even with complete oxidation the condition did not obtain which was present in the open-hearth, where a very large excess of oxygen was introduced. Moreover, furnace gases containing oxygen were absent, and consequently in the electric furnace carbon monoxide would be present in much smaller amounts.

Pearlitic Cast Iron.

Dealing with the properties and possibilities of pearlitic cast iron the lecturer said the process for producing this consisted essentially in the proper regulation of the furnace charge and the correct heat treatment of the moulds. Correct mixing was intended to give as little stimulus as possible to the formation of graphite. The materials used were carbon, silicon, and low-phosphorous pig-iron. It was also remarkable that a high sulphur content, which most foundrymen feared more than anything, did not appear to be detrimental to pearlitic cast iron. In order to produce the desired pearlite-graphite structure a slow rate of cooling was necessary; this was obtained by preheating the mould, the degree of preheating depending upon the wall thickness of each par-

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ticular casting. Theoretically speaking, it should be possible to get from the same charge and by suitable heat treatment of the mould every desired cross-sectional area with the same final product (pearlite-graphite structure) when once the rates of cooling for the different cross-sectional areas had been determined. In practice, various cross-sectional areas were grouped together, and a special burden or charge selected for each group, assuming the same amount of pre-heating of the mould.

The properties claimed for the cast-iron were (1) high transverse and tensile strengths and toughness; (2) high resistance to impact stresses; (3) moderate hardness when properly treated; (4) only a slight tendency to the formation of "pipe," and hence the possibility of making complicated castings; (5) great resistance to sliding friction (abrasion); and (6) fine and dense structure, the structure being unaffected by temperature changes. Among the possible uses of pearlitic cast iron, Prof. Carpenter mentioned its use for parts of steam and internal-combustion engines. On account of its excellent strength properties and absence of strains, it could be cast lighter, thus saving both material and weight, especially in locomotives, marine engines, etc., where the question of weight was important. Its high resistance to abrasion indicated its use where mechanical parts were subject to sliding friction, *i.e.*, pistons, piston rings, cylinders, cross-heads, gear-wheels, etc. Steel and malleable castings were often distorted and deformed owing to the heat treatment which they must necessarily undergo, whereas pearlitic cast iron maintained its original form, as it was not subsequently heat treated. Many parts which were now made from steel and malleable castings could with advantage be made from the new material in cases where the strength properties (*e.g.*, expansion) of steel and malleable-iron castings were not brought into play.

Sandberg Process of Rail Treatment.

Referring to the Sandberg process for the production of the sorbitic structure in steel and its application to tyres and rail steel, Prof. Carpenter said the attributes of the process were that the improvement it effected did not reduce the existing output of rolling mills; no scrapping of existing plant or erection of elaborate new plant was required; the improvement did not increase unduly the cost of the finished rails; it increased both the safety and the durability of the rails. The first rails treated were tramway rails, and gaugings taken from these after they had been one year in the track under very severe traffic showed that their life would be about 100 per cent. longer than that of the Sandberg high-silicon rails of the same composition, but untreated, and laid at the same time in the same track. Upon British tramways, owing to their greater resistance to battering and to detrusion, sorbitic rails had met with decided approval, about 35,000 tons having been supplied to various systems, and, in consequence, several of the largest tramway undertakings in the United Kingdom had adopted these rails as their standard. Too much stress could scarcely be laid upon the value of any suitable means of reducing the costs, and in many cases also the excessive inconvenience, of relaying track, and it was upon these costs and their reduction that the estimates for different classes of material should be based, rather than upon the mere difference in the initial price of such materials.

The lecturer also made reference to high-speed tool steels, and other alloys including the series known as "Mumetal" (so-called because the Greek letter μ was the symbol of permeability). These alloys, he said, had highly desirable characteristics, and by their use the speed of cabling could be increased seven- to eight-fold. A typical "Mumetal" alloy had the composition:—Nickel, 74 per cent.; iron, 20 per cent.; copper, 5.3 per cent.; managanese, 0.7 per cent.

Catalogue Received.

Cast Iron Pipes.—The Monthly Stock List of Cast Iron Pipes, issued by The Staveley Coal and Iron Company, Limited, of Chesterfield, for May, is now available. An additional list of specials is also included this month.

Carnegie Scholarship Awards.

At the second day's proceedings in the annual meeting of the Iron and Steel Institute at the Institution of Civil Engineers, Westminster, with Mr. F. W. Harbord (President) in the chair, the Secretary (Mr. G. C. Lloyd) read the list of the Carnegie Scholarships that had been awarded as follows:—

David Binnie (Royal Technical College, Glasgow) graduated B.Sc. in metallurgy in July, 1924, with special distinction in advanced inorganic and physical chemistry. Since October, 1924, he has been engaged as assistant in the Physics Department of the Royal Technical College, Glasgow, and has latterly been engaged in carrying out original investigations with a view to obtaining his Ph.D. degree. Among the researches already published by him may be mentioned "The Magnetic Properties of Permalloy," and "Overstraining of Steel by Bending." He has been awarded a grant of £100 to carry out research work, under the direction of Prof, J. H. Andrew, at the Royal Technical College, Glasgow, on behalf of the Heterogeneity Committee, to determine the liquidus and solidus of carbon and alloy steels, and to study sulphides in liquid and solid steels.

B. S. Smith (Sheffield University) has taken the Honours Degree course in metallurgy at the University of Sheffield. During the final year of this course he has been engaged on the investigation of the problem of "Martensite." He receives a grant of £100 to assist in carrying out research work, under the direction of Prof. C. H. Desch, on behalf of the Heterogeneity Committee, the subject being the study of the viscosity of molten steel.

T. F. Pearson (the University, Birmingham) obtained the degree of B.Sc. First-class in metallurgy at Birmingham University, and afterwards took a position as blast-furnace chemist at Messrs. Baldwin's blast furnaces, Netherton. He receives a grant of £100 to carry out a research on Graphitisation on iron-carbon alloys.

Emanuel Valenta (Skoda Works, Pilsen, Czecho-Slovakia) studied metallurgical engineering at the Mining and Metallurgical High School, Pribram. For 6½ years he has been engaged as metallurgical engineer at the Skoda Works and has made special investigations on rust-resisting and anti-magnetic alloys manufactured in the electric furnace. He receives a grant of £100 to study heat- and acid-resisting cast-irons containing chromium, silicon, and aluminium.

G. R. Woodvine (Shrewsbury) has for nine years been chief metallurgist to the Sentinel Wagon Works, Limited. He received his practical training under Mr. Brearley at Sheffield, and was for some years associated in research work with Dr. Aitchison. The following papers have been presented by him to the Iron and Steel Institute: "Behaviour of Case-hardened Parts under Fatigue Stresses" in 1924, and "Influence of Segregation on Corrosion of Boiler Tubes" in 1926. He receives a grant of £100 to study the influence of nickel on wearing properties of case-hardened steel.

Frederick Collis received a grant of £100 to assist him in carrying out research on heat treatment, particularly with reference to blast-furnace stoves.

Mr. Morgan (Birmingham University) would also receive a grant for the purpose of carrying out a research.

Serious Pattern-Shop Blaze.

A serious fire broke out last week at the foundry of Messrs. Cameron & Roberton, Limited, of Kirkintilloch. It has completely destroyed the pattern shop and has to certain extent damaged the fettling department. We understand that arrangements have been made to carry on business as usual.

Notes from France.

Mr. Dalbouze, president of the French Engineering Employers' Federation, and Mr. Denis, manager of the O.S.P.M., have been made an Officier and a Chevalier of the Order of the Legion d'Honneur respectively.

M. Buffet, who was lately with the Compagnie Alsacienne des Constructions Mecaniques, has joined the staff of the Campagnie Generale des Conduites d'Eau, Liege (Belguim).

The Influence of Sulphur in Cast Iron.

By J. E. Hurst.

(*Continued from page* 316.)

Iron Sulphide.

In the absence of manganese it is generally accepted that the sulphur exists in the iron as the sulphide of iron, FeS. It is in this form that the sulphur is alleged to exert its influence in retaining the carbon in the combined form and thus preventing graphitisation.

The compound FeS has a melting point of 1,180 deg. C. and a specific gravity of 5.02. It has a limited solubility in pure iron, and forms a eutectic with this solid solution, having a melting point of approximately 980 deg. C. The effect of the presence of carbon and silicon on the solubility of iron sulphide has not been thoroughly investigated. The existence of a ternary eutectic has been confirmed, but whether this exists in the presence of silicon is uncertain.

In the light of all our existing knowledge we are justified in making the hypothesis that FeS is soluble in liquid cast iron, and to a limited extent in the solid cast iron. How the dissolved sulphide is distributed, whether in the austenite or cementite, we are unable definitely to say.

The influence of sulphur in the condition FeS in preventing the formation of graphite has been well established by various workers, including Stead, Levy, Hatfield and others. The demonstration of this influence in low-silicon alloys for malleable castings has formed the basis of the most conclusive proofs of this influence of sulphur. The recent additional evidence furnished by Kikuta will be interesting to quote here in demonstration. It will be noted that when the sulphur is in excess of that required to form MnS the graphitisation becomes increasingly difficult, and the so-called second-stage graphitisation was incomplete under the conditions of the experiment.

The influence of iron sulphide on the graphitisation of grey irons has been extensively investigated by Piwowarsky. All his samples contained 0.26 per cent. manganese, which requires 0.15 per cent. sulphur fully to convert this to MnS. It may be assumed for the purposes of comparison that the sulphur contents up to this percentage are all in the condition MnS, and above this value increments of sulphur represent increments of FeS. The A curves represent conditions of slow cooling and the B curves represent conditions of quick cooling, and the curves are plotted for various silicon and total carbon contents.

The most astounding result to many foundrymen disclosed by these curves is that, with quite normal silicon and total carbon contents with slow rates of cooling, the sulphur can exist—as iron sulphide—up to a sulphur percentage of 0.6 to 0.75 without any serious diminution in the extent of the graphitisation. The influence of speeding up the rate of cooling, variation in the total carbon and silicon contents, are also demonstrated. The marked effect of the influence of quicker rates of cooling demonstrates the influence of sulphur in the iron-sulphide constituent in increasing the liability to chill.

One of the most important demonstrations of these curves is the fallacy of attempting to describe the influence of sulphur without reference to the remainder of the chemical composition and the cooling conditions. This is a fault common to many descriptions of the influence of constituents on cast iron, particularly those "potted varieties" served up to engineers. In no case is this fallacy more clearly demonstrated than in this one under review. Almost universally sulphur has been condemned as having a detrimental influence, yet when considered in reference to other features it may have a useful and beneficial influence, and, in fact, does enable results to be obtained which would be impracticable in any other way.

Interpretation of Modern Theory.

In the absence of manganese there is a general tendency for the presence of increasing quantities of sulphur to prevent graphitisation, and, as a result, to increase the hardness, liability to chill, and total shrinkage of the castings. This general tendency is resisted by the silicon content and also by the rate of cooling. Where the silicon content is high or the rate of cooling slow, quite large percentages of sulphur may be present without any serious effect on the extent of the graphitisation. As the silicon content is lowered or the rate of cooling quickened, the tendency of the sulphur, in the absence of manganese, to increase the hardness becomes more and more predominant. In all commercial cast iron some manganese is present, and, in accordance with the amount present, some of the sulphur must be rendered innocuous as a result of the formation of manganese sulphide. This fact further reduces the risk of any serious trouble arising out of the sulphur content.

The Influence of Sulphur on the Mechanical Properties.

From a practical point of view, probably the best method of demonstrating the influence of

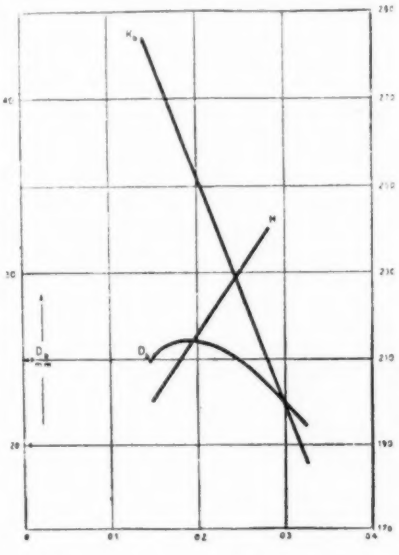

FIG. 1.—SCHMAUSER'S RESULTS.

sulphur lies in the examination of its influence on the mechanical properties of cast iron. Obviously it is not of much use answering the engineer's or foundryman's query, as to what is the influence of sulphur, by telling him that under certain conditions sulphur prevents graphitisation, and under other conditions it has exactly the opposite effect.

Many investigations have been made on the influence of sulphur on the mechanical properties, but, unfortunately, these investigations have not been made with the object of demonstrating the influence of this constituent on the lines of the modern conception already outlined. The results of Schmauser (Fig. 1) were obtained on a cast iron of the following composition:—Tot. C, 3.0; Si, 2.2; Mn, 0.5; and P, 0.7 per cent. A rapid fall in the strength properties accompanied by an increase in hardness is disclosed by these investigations. To contrast with these investigations, there are the results of Hamasumi, where the influence of sulphur shows a general tendency to increase the hardness and also the strength properties. These are typical examples of the contradictory nature of the various investigations which have been published. Any consideration of such results is at once rendered futile by the lack of the necessary information as to size of test pieces and cooling conditions, and, most important of all, the condition in which the sulphur exists.

A series of results have been obtained on white-heart malleablised cast iron, from which it is

accompanied by a decrease in strength properties and difficulty of machining if its effect is exerted on an initially close-grained cast iron. In other words, the influence of sulphur in the condition of FeS is dependent upon the rest of the composition, particularly the silicon content and the rate of cooling. It is possible to imagine that under conditions of silicon content and rate of cooling such as those outlined in the high-silicon members Group A of Piwowarsky's experiments, that the influence of sulphur up to percentages much larger than commonly met with would be negligible, even in the FeS condition.

The general uncertainty of the actual test results published would appear to confirm this general view, and to quote Piwowarsky's own words: "any exaggerated demands calling for the removal of the last traces of sulphur in high-manganese cast iron are not sufficiently borne out by the practical and scientific investigations hitherto carried out."

In actual present-day practice, the manganese content of cast iron is usually sufficiently high to take care of all the sulphur normally present. A percentage of manganese of 1.0 per cent. in a common iron containing 2.5 per cent. silicon will probably take care of sulphur up to 0.5 per cent.—a value which is rarely met with except under very abnormal conditions.

Limit of Safety in Content.

From the point of view of general foundry practice it is, of course, difficult to place a really definite maximum limit to the sulphur-content above which the results are likely to be disastrous. Such a limit cannot be defined strictly without reference to the other conditions of composition and cooling conditions. From the considerations above, it appears to be certain that in an iron containing 2.75 per cent. Si and 1 per cent. manganese, a composition which is commonly used in these days even the maximum limit of sulphur of 0.30 per cent. mentioned by Moldenke can be exceeded. There must be many foundrymen who have knowledge of this figure having been exceeded during the recent coal strike without being accompanied by disastrous results.

It will also be evident that by careful adjustment of the manganese and silicon to allow of the sulphur existing partially in the iron-sulphide condition, the sulphur may be utilised in the manner suggested by Rhead to maintain the hardness of the metal. We may quote a practical example[e] mentioned by Mr. H. J. Young, in which he states that liners of very hard iron have been at sea for eight or nine years containing nearly 0.25 per cent. sulphur, a value considerably in excess of the limits imposed by many of the text-books.

From an examination of these and other published test results in the light of modern conception of the influence of sulphur, the necessity for the reinvestigation of the influence of this constituent in this respect becomes apparent. The author has no data whatever from which to determine the intrinsic influence of the sulphur in the condition of Mn, S, and FeS respectively. For this reason one's conception must of necessity be based on inference.

From an application of the inferential method we are justified in concluding that, providing the sulphur exists in the form of MnS, in which form it is without influence on the condition of the carbon, it is likewise without influence on the mechanical properties. When the sulphur exists as FeS, with its tendency to maintain the carbon in the combined condition, its influence on the mechanical properties will be exerted in the direction of increasing the hardness. This increase in hardness will be accompanied by an increase in strength properties if its effect is exerted on an initially soft and otherwise open-grained cast iron. The same influence will be obvious from the composition that the sulphur exists as the iron sulphide. The outstanding feature is that, apart from the elongation, no serious influence of the sulphur is felt until a percentage of between 0.4 to 0.5 per cent. is reached. Similar results are demonstrated by the Izod impact tests.

It is, of course, undesirable to utilise high-sulphur irons purely for the sake of using them, as in any event it is superfluous to increase the amount of the impurities in cast iron without any substantial reason. At the same time, it will be appreciated that many varieties of iron, both scrap iron and pig-iron, which in normal times are rejected as containing too much sulphur, might with care be used with no harmful results.

Conclusions.

To enable a conception of a concise nature to be obtained of the influence of sulphur might be briefly summarised as follows:—

(1) In the presence of sufficient manganese, at least in the ratio of 3:1 in lower-silicon iron, the sulphur is converted to MnS, in which form it is harmless up to quite appreciable amounts. (In higher-silicon irons the excess of manganese over the theoretical amount is probably much less than the above ratio.)

(2) Even in the absence of sufficient manganese, the presence of FeS in appreciable quantities will not have any serious effect in the presence of the higher silicon and total carbon contents, and particularly when the rate of cooling is comparatively slow.

(3) It is highly probable that in the presence of manganese the comparatively high safe limit of sulphur specified by Dr. Moldenke, viz., 0.30 per cent., can be exceeded with safety.

(4) Quoting Piwowarsky's own words as the final conclusion that "the exaggerated demands for the removal of the last traces of S in high Mn cast irons are not justified in the light of modern knowledge."

Finally, one of the main reasons for the choice of this subject is with an eye to the future. Modern tendency in the development of the metallurgical side of foundry practice is towards the use of low total carbon-content irons, and this tendency will be considerably hastened if low total carbon-content irons become available at a price comparable with ordinary foundry pig-iron. As far as I can see, the various methods available for the production of such low total carbon-content irons, either direct from the blast furnace or by other semi-synthetic methods, the pig-iron is likely to be accompanied by a sulphur-content higher than normal. This has often been raised as a serious objection, and for this additional reason it becomes necessary to point out that the findings of investigation, so far as it has progressed up to the present, is that the influence of sulphur is not likely to be accompanied by anything like the disastrous results which many text-books indicate.

Growth of Electric Furnace Industry in U.S.A.

In a Paper entitled "American Electric Steel Expansion in Twenty-five Years," presented to the American Electro Chemical Society, Mr. E. F. Cone stated that the national growth in electric steel furnaces was from six to over 500 during the period under review, with an annual production of 600,000 tons. He stressed the point that large tonnages of alloy grey cast iron were being made.

Carbon and Silicon in Cast Iron.

We regret that this article, published in our last issue, contained a misprint in the name of the author. The Paper was written by Mr. Archibald Allison, of Sheffield. We regret any annoyance which this has caused Mr. Allison.

Personal.

Mr. Paul Ropsy, president of the Belgian Foundrymen's Association, and a member of the Institute of British Foundrymen, intends being in Sheffield for the annual Congress.

Mr. John Hill, of Messrs. Hill & Griffiths, of Cincinnati, manufacturers of foundry supplies, returned home from London last Friday, after having taken an extensive tour in the Far East and Europe.

Mr. John A. Penton, a past-president of the American Foundrymen's Association, is spending this summer in Europe. He is at present staying at the Hyde Park Hotel, London. He expects to be in Sheffield for the annual Congress of the Institute of British Foundrymen.

Runners, Risers and Gates.*

By J. Butterworth (Halifax).

Foundrymen do not give the subject of runners and gates and risers as much attention and thought as they should. It is left too much to the abilities and skill of the moulder, without giving him any instruction as to how the particular casting is to be machined or fitted. Although this system has worked fairly well in the past, the subject will have to be a separate study on account of the great increase in machine and plate moulding methods of production.

Foundrymen are simply left to use their own judgment from past experience, and adapt their methods of production to suit the pattern. This is an insult to the foundryman in general, as every other department in connection with engineering see the drawings and adopt their own methods for producing the finished article.

Runners, Their Economy and Size.

The object of the runner is to introduce molten metal into the mould, and to have more runner and gate than is necessary is a waste of both time and material. Their cost might not seem high when regarded from the point of view of a single casting, but examined in the light of the production of six or twelve months the extra cost becomes apparent.

The selection of the size, shape and position of the channels by which the metal shall enter the mould is a matter of great importance. The shape and weight of the casting must be fully considered, as well as parts which are required to be sound and clean.

The size of the ingates is determined by the weight and the shape of the castings, and also the temperature of the metal necessary at the time of pouring. The openings must be so arranged that they are sufficiently large to allow the mould to fill without the metal becoming stiff, and so producing short-run or seamy castings. They must not be made too large, so that there is but little control over the metal during pouring, in which case dirty castings will result.

Round or Square.—There are numerous methods used, the round and the square types of down runner being most common. The author generally prefers the round type, because when drawing a square runner from the sand the moulder always leaves a ragged corner, or loose pieces of sand in the corners. Especially is this so in greensand work, and the wash of the metal is sure to carry these loose pieces into the mould. When using the round type of a down runner, the safer type of pear-shaped plug can be used. The flat type as used for square runners is dangerous, because it requires holding, whereas the pear-shaped type holds itself.

Gates.

The selection of the size, shape and position of the channels by which the metal shall enter the moulds is also of great importance, and the nature, shape and weight of the casting must be fully considered. The size of the ingates must be determined, as these are also controlled by type of casting, the temperature and composition of the metal.

Light Castings.

Some light flat castings are run on the side: sometimes with one long shallow runner, but in other cases two or more; again, some are run directly on the top with a V or wedge-shaped runner, depending upon the thickness and size of the casting.

Gas Cooker Side.—Gas cooker side castings, 20 in. × 28 in., and 3/16-in. thick, should always be run with wedge-shape runners from the top on account of the contraction. They have been tried by running at the sides with spray runners or gates, but it was found that the contraction pull on the runners warped or even cracked the casting, but after adopting the wedge-shape runner on the top of the casting, and knocking out the sand in the top part directly after the metal was set, this difficulty was overcome, and less metal was required to form the runner.

Flat Plate ¾ in. Thick.—A similar plate, but, say, ¾ in. thick, to be machined all over, would be wasted if run from the top, on account of the tearing by the metal stream on account of the drop. This would make a scab, no matter how well it was vented. The better method would be to run it at the side with as many flat gates or sprues as possible. The down runner at one end and a skimming gate at the other, with a connecting channel cut in the top part from the runner to the skimming gate.

Small Blank Wheels.

When making small blank wheels on the plate some patternmakers will persist in so placing the runner that the first metal enters the mould at the rim of the wheel, which is inadvisable, because wherever the runner is connected to the casting, that point is the most liable to be spongy or dirty. A blank wheel should always, if possible, be run from the boss with a pencil-like runner. If the boss is a heavy one and requires feeding, then a riser is put on the boss opposite the runner. It is desirable always to have a flow-off riser from the rim, and to run well through. Should there be more than one on the plate, then adopt the spinner method of running so that the first metal enters the spinner. The channel should be cut in the top part and the ingates in the bottom part and cut the opposite way to which the metal is expected to spin. The down runner and channel should be twice as large as the combined openings of the ingates, and by so doing the spinner is flushed before any metal enters the mould, as shown in Fig. 1.

Plate Pulleys.

In the making of a plate pulley it is generally found that it is run on the boss on account of the ease of making the mould, but from personal experience the author believes it is better to run such a casting, especially when it is made from the loose pattern or a loose rim, from the bottom by cutting a V-shaped runner or ingate under the bottom edge of the rim at the tangent. It is much safer, because instead of having an outward pressure on the sand forming the boss, there is an inward pressure on this part of the mould. This helps to hold the sand by pressing it together from the outside, and in so doing one incurs less risk of having a burst. There is less chance of the plate scabbing, because in running from the bottom all the gases are driven in an upward direction, which gives them a better chance of escaping before the mould is full. When the metal reaches the plate it flows over in a free and easy manner. Otherwise, as soon as the bottom boss is full, the metal rushes over the plate in a tearing sort of manner caused by the pressure from the drop of the metal. This action of dropping into the bottom of the rim causes an explosion of the gases which have accumulated in the vents and rim, thus loosening the sand on the face of the plate and resulting in a scab. By using the method shown in Fig. 2 the casting in some cases does not require feeding, due no doubt to the compression of the metal having to force its way in an upward direction and thereby feeds itself by its own weight.

The Top and Bottom Running of Medium and Heavy Castings.

When dealing with medium and heavy castings one encounters the top and bottom running problem in an intensified form. Some moulders are insistent that bottom running is preferable on account of the drop of the metal and the lift or pressure of the metal as it reaches the top part. It may be, however, that the gases accumulate in a closed mould quicker than they can escape through the vents, and as the mould is filling they are pressed against the top part to such an extent that it is lifted, unless it is securely fastened

* A Paper read before the West Riding of Yorkshire Branch of British Foundrymen. Mr. W. Parker presiding.

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down. Other moulders prefer top running, insisting that there is no difference between this and bottom running, providing there is no obstruction in the mould which is liable to wash away with the fall of the metal. The metal has to drop to the bottom in both cases, and provision can be made to receive the fall without doing any damage to the casting. A casting should be run in the most convenient place and as far as possible away from all machined or polished parts, but where easy distribution of the metal can be obtained without obstruction, taking into account strains, contraction pulls and density. The advantages in top running are that the gates are more easily made and with care can be immune from dirt; the metal has a shorter drop before entering the mould, and thus is more mobile than would be the case in bottom running under similar gating conditions. In top running the metal is obviously hotter at the top and less metal is required on account of there being less down runner.

Advantages of Bottom Running.

Because the metal drops to the base of the down gate, any tearing or washing away of sand is at this position and not on the casting, and so reducing the liability of scabbing at the bottom of the mould. Moreover, there is probably a denser structure of the metal throughout the casting due to compression. Providing the runners are clean, bottom pouring gives a cleaner casting having an improved skin.

Engine Flywheel.

The author is of opinion that it would be foolish to attempt to run an engine flywheel in any position except on the boss, in spite of the fact that it has to be machined and bored there. Running it on the rim would not assure the same distribution of metal, probably resulting in the flats on the rim being badly scabbed. Running it on the arms would also give a poor distribution of metal, involving contraction stresses on account of the runner solidifying first and pulling against the arms. Obviously, therefore, the boss is the most suitable location.

Engine Bed.

An engine bed or base plate should not be run at the top, although they are moulded with the base of the bed uppermost. The proper method is to ensure that the runner is as near the bottom as is convenient for easy and clean running. The position which suggests itself is up each side of the cylinder core at the cylinder end, because these locations ensure easy distribution of the metal. There is but little fear of any damage from contraction pulls, whilst it gives solid metal at the cylinder end, the important part of the casting. The result is no doubt due to the compression by the metal having to force its way in an upward direction in order to fill the mould. Finally, if any dirt is taken in with the metal at the runner, it has a reasonable chance of being carried forward to the top of the mould away from important parts of the casting.

Sewage Plate.

Sewage plates are made in various sizes, but as an example one about 4 ft. sq. may be cited. It is 2 in. thick on the outside, dome-shaped, fluted on both sides, and is about $\frac{1}{2}$ in. deep. On one side there is a lip about 3 in. wide which is from $\frac{1}{2}$ to $\frac{3}{4}$ in. thick, whilst at the opposite end there is a $\frac{3}{4}$-in. round core, bottled-necked at each end to $\frac{1}{2}$ in. dia., which runs the whole length of one side, and the body of the core is completely covered with metal. If this type of a casting is run at the thickest part, the metal would be flowing against the run of the flutes, and in all probability a number would be washed away. On the other hand, if they are run contrary to accepted notions, sound castings can be produced, providing the ingates are cut correctly and the area of the down runners is smaller than the combined area of the ingates. It has been found that the ideal place at which to run this type of casting is on the $\frac{1}{2}$-in. lip, so that the flow of the metal is running in line with the flutes. At one time this casting was made with the dome downwards, with two large down runners and four rectangular ingates about 3 in. × $\frac{3}{4}$ in. thick. It resulted, however, in the metal as it ran over the face of the mould driving the air to the far end of the casting, sometimes disturbing the flutes and generally causing a blowing effect on the round core at the top edge. The better way is to mould the casting dome uppermost and to run it by means of two 1-in. round down gates connected to two separate channels, each one having three dome-shaped ingates, approximately 2 in. × $\frac{1}{2}$ in. at the channel end, increasing to about 3 in. × $\frac{1}{2}$ in. at the casting end. This gives a rush of metal in the channel and not over the flutes, and by the time the metal enters the mould it is running freely (Fig. 3). The metal has to climb up the dome, and by the time it reaches the top the gases are driven to the far end where the risers are conveniently situated. By the time the metal reaches the core the mould is almost full, and so the core is covered almost instantaneously, and if the vent is left open at the ends, no blowing effect takes place.

Wheel Ring.

A wheel ring, 14 ft. dia. × 10 in. deep, which is flanged on the bottom side and has metal thickness on the ring of 4 in. and 2 in. on the flange, presents features of interest. There are 165 teeth of 2-in. pitch, and additionally 16 ribs on the inside of the ring. There is also a split rag joint. On the underside of the flange there is a ring 2 in. wide, $\frac{1}{4}$ in. deep, containing 16 washers $\frac{1}{4}$ in. thick, which are also used for bedding the grooved pulley during erection. The weight of the casting is about 35 cwts. It is essential that the castings should be sound, as they are used in pit haulage work, where they carry a rope pulley weighing about 2 tons; there is an 18-ton load on the wire rope, and a number of overhead trucks. The ring is moulded in green sand in the floor, and the teeth are made by the machine. It is difficult to run owing to the design and size. It requires two sets of runners and two ladles of metal casting simultaneously, because of it being split and the liability to contortion.

Now there are three ways of running this casting. Presumably one could start by running straight down the ring side with drop runners, but this is liable to disturb the teeth. Again, running direct on the top of the flange, or by running into the flange at the bottom, suggest themselves. The former method, using six $\frac{3}{4}$-in. dia. round runners, three in each half of the ring placed 12 in. apart, was finally adopted, because it takes care of the contraction. This method necessitated the runners being placed in the cores, which were made in oilsand and well blacked. Thus the cores yield as the ring contracts, and there is no pull caused by the runners setting before the casting (Fig. 4).

Secondly, the runners can be so placed that the metal would drop into the ring-like washer which encircles the bottom side of the flange, acting like a channel connecting two or more ingates, and ensuring easy distribution over the face of the mould. Again, the runners were easier to make. It was a cleaner method (providing plugs were used in running the casting) than would have been the case if run at the flange on the bottom, because the runners would have to be cut into the core print or seating, and the down runners would have had to be rammed up after the ingates were cut and the cores set. Finally, the top-running method was the safer, as there is little fear of the metal tipping or pushing the cores forward into the teeth.

Pipes.

There are no less than five different methods used for running pipes, and every method has produced good castings. Straight lengths, bends, and T pipes are often run on the top of the body with one or more runners. Sometimes they are run in at the side of the body with flat spray gates and V gates. Alternatively they are run on the top and at the side of the flange, and also up each side of the core at the end of the pipe.

The author's preference is the last method mentioned, because the runners are easily made and kept clean: the metal is always running in the same direction as the vent, and by so doing one is always "chasing" the vent instead of trapping it, and finally there is little fear, especially in the case of a thin sectioned

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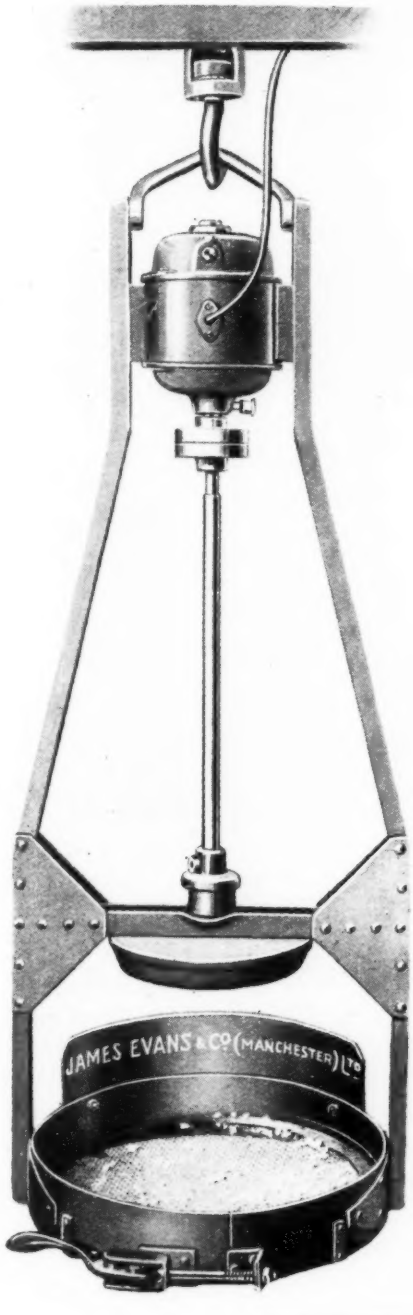

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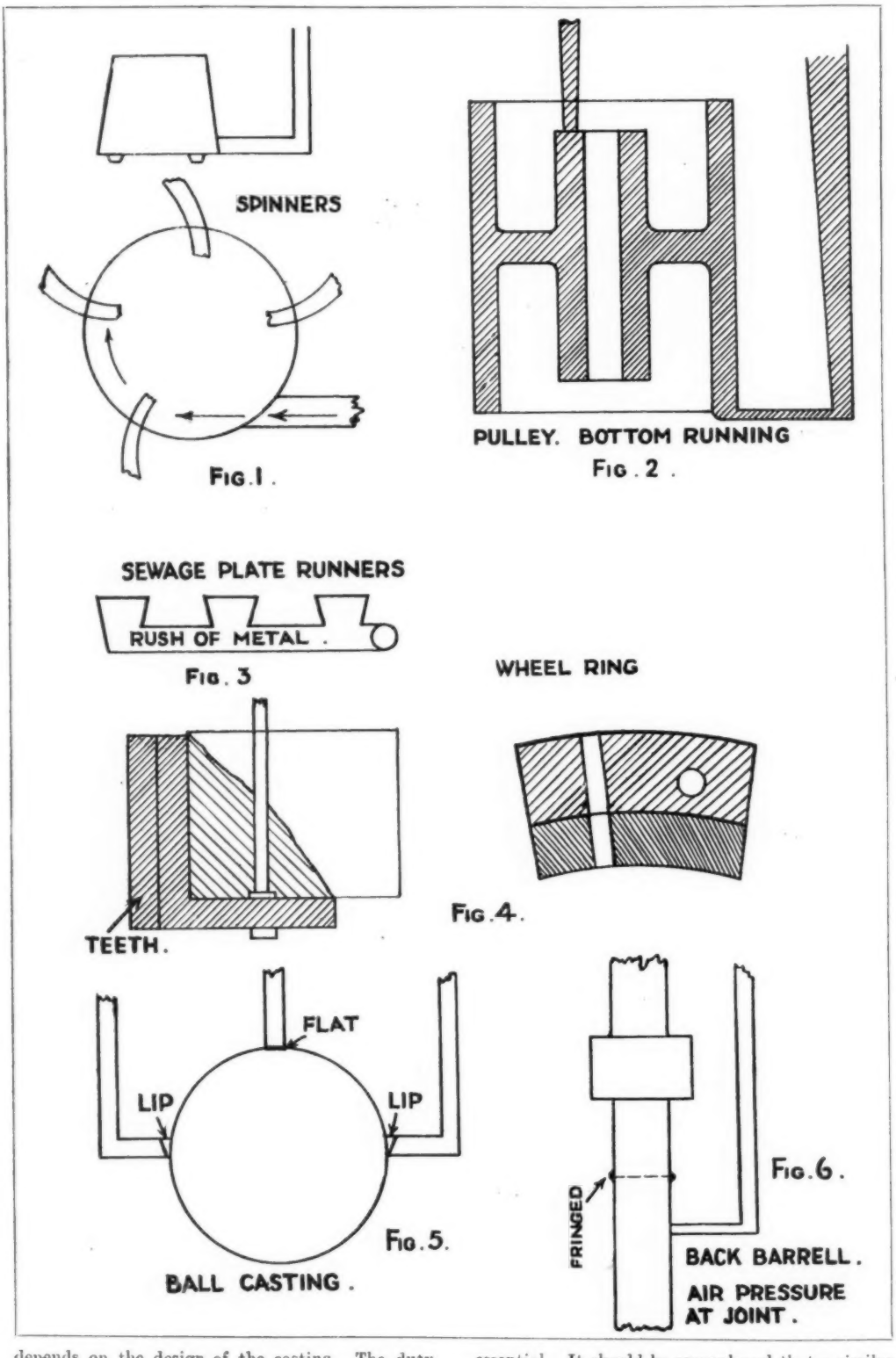
pipe, of doing any harm should a runner break in through carelessness, either in the construction of the runner or in knocking it off. The runners are away from all scotchings and weights.

Risers.

In dealing with the riser problem much depends on the design of the casting. The duty of a riser is to form an opening whereby fresh supplies of metal can be put into a mould to give solidity to the casting. A riser is placed on to a casting to relieve the mould from strain. When a riser is required for feeding purposes it does not mean that it should always be placed at the highest point, but it should be so placed that the fresh metal will reach the point which is acting as a reservoir to the other part of the casting. If this is not done, then a cavity will result. The riser ought to be made as large as possible to allow the metal to get into the casting. However, if there is a boss, say, 6 in. dia., one should not put a 5-in. riser on, but nothing less than a 1½-in. riser should be used if solidity is essential. It should be remembered that a similar action is taking place in the metal of the riser as that in the casting. It is well known that solidification of the metal commences from the outside or outer surface—the part nearest to the sand, and if the riser is not large enough to be kept open by means of feeding it will set before the casting, and in that case it might as well have never been used.



No. of Alloy	Specific Gravity.	Melting Point °C.	Test Specimen.	Average Tensile strength Tons—sq. in.	Average Elastic limit Tons—sq. in.	Per cent. Elongation on 2 in.	Remarks.
4	2.75	643	Sand cast	6.5	4.5	4	A light copper alloy which is an admirable substitute for soft brass. Is very ductile, and has a high shock resistance.
			Chill cast	9.5	5.0	8–11	
6	2.98	615	Sand cast	13.0	8.5	4	A copper-zinc alloy which is very strong, easily cast and suitable for general purposes. It has excellent machining qualities.
			Chill cast	13.5	9.0	5	
6a	3.12	600	Sand cast	16.0	12.0	2	Stronger, but heavier than No. 6. Will take a very high polish.
			Chill cast	17.5	11.0	5	
12	2.83	629	Sand cast	7.0	6.0	2	A very reliable non-porous copper alloy. Is largely used for die-castings, as well as for sand castings.
			Chill cast	10.5	7.0	4	
38	2.88	622	Sand cast	9.5	6.0	5	
			Chill cast	11.5	5.5		
50b	2.72	645	Chill cast	9.0	6.5	13	A light nickel alloy which makes hard ductile castings, suitable for mathematical instruments, etc

The above figures are average test results made on specimens cast to 1 in. diameter and machined at the centre to 0.564 in. diameter.

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Taper Risers.

On a heavy casting, which requires feeding, there is an advantage in having the riser stick tapered for the reason outlined above, and additionally it allows of a freer escape of the gases as they are being driven forward by the heat of the metal to the outlet, especially if the metal happens to be "dull." A riser having a smooth, round hemispherical surface is caused by the gases in the molten metal being unable to escape on account of the chilling effect the metal receives on contact with the riser. If a tapered stick is used there is a better chance of successful running, because the hotter metal which is under the chilled portion has a better chance of breaking through and lifting the ball of metal containing the trapped gases into the open bush.

Ball Casting. (Fig. 5.)

In the case of a sphere, a solid casting can be made easier and better by cutting a riser at the side, having a large down-gate and keeping the metal working through to the runner by feeding. It is generally found when a riser has been placed directly on the top of a ball casting, although it has been fed, there is a flat sunken place to be found just round by the bottom of the riser, and when the riser is broken off it leaves a flat surface, but if a riser is cut at the side the metal is pressed into the centre of the casting by the continuous motion from riser to runner, and *vice versa*. When the riser and runner are broken off the casting they leave a small lip at the top edge, which can be dressed by very little chipping or grinding and leave the ball perfectly spherical.

Dummy Risers.

The functions of a dummy riser are supposed by some to be the following:—(1) to allow any dirt to be removed from the casting, and (2) to feed the casting. The first suggestion is totally wrong, because if any dirt enters a dummy riser it does so entirely by chance, as such extraneous matter will stick to the first obstruction it happens to touch. This can be seen on any casting having a top riser, where it looks as if the moulder has rubbed his thumb round the bottom in making his riser and then left it, leaving a rough uneven surface. An outstanding example of dirt adherence is plainly seen on the shanks and ladles, otherwise there would be no need to daub and fettle them after each day's melt. In the case of a bad runout, it is found that the first metal, nearest to the sand, has formed a skin or a shell, and apparently if any dirt touches this skin it sticks, otherwise specks of dirt will not be found during machining after this skin has been removed.

Thus dummy risers are useless for cleaning a casting, but they help to give solidity providing they are sufficiently large. If they are too small they set first, and then the riser will not rob the casting of metal and a cavity will be found directly underneath. Dummy risers are unnecessary, as it is very seldom one encounters a casting where the vital point cannot be dealt with by means of an ordinary riser, and in any case one can use a densener, which is a more effective and cleaner method.

A case came to the author's notice of two moulders who were making a back barrel casting for a lathe. It was 3 or 4 ins. diameter, and about 18 ins. deep, and solid. This (Fig. 6) casting has to be machined all over and machine-cut teeth have to be provided at the pinion end. Both moulders ran the casting half way down the barrel with a dirt riser attached. But one of them placed a riser about 1 in. diameter on the top and fed it, and although the metal was adequately skimmed, his castings were returned from the machine shop, being both dirty and spongy. The other placed a riser about 2¼ in. diameter on the top, or about 1 in. less than the diameter of the casting. He never fed his castings: as soon as he had cast the mould he used to cover the riser with dry parting or sea sand and leave it, insisting that the riser being almost as large as the diameter of the casting, and the parting sand being dry, the metal would remain fluid as long in the head as it did in the casting, and that being so the casting would draw the metal down from the head and feed itself solid. Additionally the castings were clean.

Strain and French Risers.

Another type of riser that is commonly used is the French or flow-off riser, which, when placed on the top edge of a casting, is more efficient in relieving strain than one placed directly on the top. The metal in filling a mould does not drive the gases in an entirely upward direction, because the vents are continually sucking the gases to the outer surface of the mould. A good illustration of this movement can be seen when making a deep mould, where it is necessary to make a joint between top and bottom of the mould. It does not matter how hard it is rammed, there will always be found a fringe if not an actual swelling, even if the joint has not been disturbed. This is caused by the gases making their way out at this point. If this happens half-way down the mould, it is obviously more likely to occur at the top joint. Thus the flow-off riser, when placed at the top edge of a mould shows a distinct advantage over one situated directly on the top of a casting, as it allows of easier escape of the gases.

It is not the metal which lifts a top part but the pressure of the gases, and thus more weight is necessary at the runner end of a mould. The gases are trapped at the runner end owing to the down runner being kept full of metal.

Open and Closed Risers.

If castings, having a large, flat surface and thin in section are being made, then better results can be obtained by leaving the riser open, because as soon as pouring is commenced the mould is full almost immediately, and the open riser allows a free egress for the air. There is no time for suction or drawing of air, and so the mould is quite safe with the open riser.

For loam and dry sand work the question of whether the risers are to be left open or be closed seems to have been established more from custom than from logic. One shop casts all its moulds by having the risers left open, whilst others would not envisage such a procedure.

When metal is poured into a mould which has all the risers tightly closed, the air is compressed. Iron dropping into compressed air cannot drop with such a dead fall as it would if there was no compression, and additionally cannot rise so quickly as it would otherwise.

These ideas seem to give sufficient reasons for drawing the following conclusions. When iron is poured into a loam mould from the bottom it is very often best in thin castings to have the risers open, this will allow the iron to rise up more freely and faster. Whenever a mould is cast "open" the area of the risers should be large enough to permit the air to pass off freely. It is often best when the iron is dull to leave the risers open. Blow holes in the upper portion of dry sand or loam castings are often due to the dullness of the iron not allowing the collected gases a fair chance to escape. When a mould is burnt badly it is better to keep the risers closed as there will be a compression against its surface.

The open riser, especially when placed on the top of a casting in a green-sand mould, has a tendency to cause a scab on the side of a casting as well as the top, because the gas rushing out of the open riser during casting is not entirely the air that has previously filled the mould, but a mixture with gases that are being drawn through the face of the mould and gases from the metal. The open riser acts as a chimney, or flue, and instead of the gases entering the vents provided, they are drawn from the back of the mould inward through the same channels, and in doing so often enough bring patches of sand with them, causing a scabbed and dirty casting. On the other hand, if the risers are sealed, the gases which accumulate in the mould form a support for the sand in trying to force their way out into the vents. Thus the sand in the top portion of a mould, especially in a large casting, retains its shape, although it is sure to be slightly burnt before the metal reaches it. If it was not for these gases forming this support, the sand would simply crumble away. If the gases cannot get away fast enough through the vents they will force their way through the joint, up the gaggers and up the box bars, as can be seen in any unvented top part.

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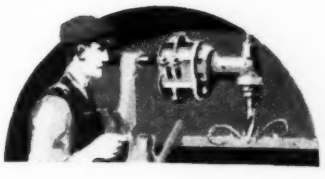

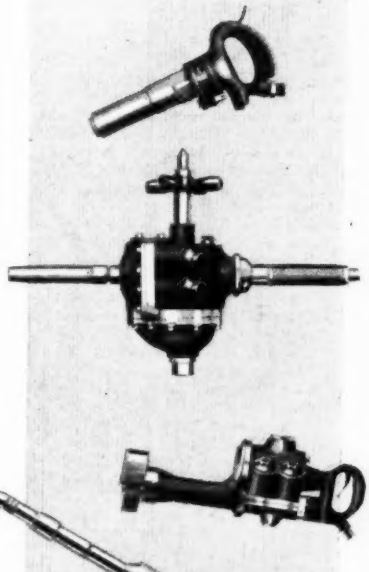

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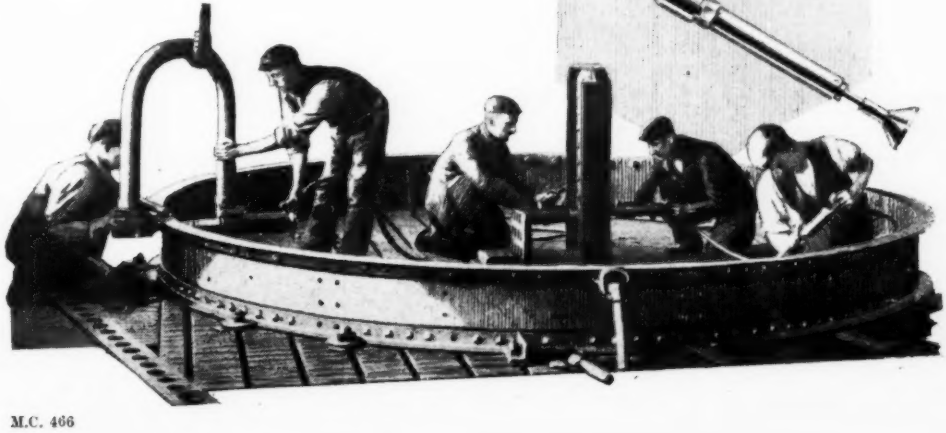

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Trade Talk.

The imports of foreign iron ore at the Senhouse dock at Maryport last week amounted to 4,000 tons.

The Briton Ferry Works, Limited, have one furnace in blast making hematite and one furnace is being repaired.

The business carried on at Shotts by the Furnace Gases Company, Limited, has been acquired by the Shotts Iron Company, Limited.

Following the death of Lord Cowdray, the head of the firm, S. Pearson & Son (Contracting Department), Limited, has decided to take on no new contracts.

The new blast furnace at Cardiff of Guest, Keen & Nettlefold, Limited, has just produced a record output of 3,500 tons in a week. The previous highest output was 3,400 tons.

The British and Continental South African Line have decided to inaugurate a new general cargo line from Newport Docks to South Africa. The steamers will definitely call at Cape Town, Algoa Bay, Durban and Delagoa Bay.

The Armourers' and Brasiers' Company have arranged for holding this month lectures by Dr. W. H. Hatfield on "Special Steels and their Application in Engineering," and by Mr. Ulick R. Evans on "Oxidation, Corrosion and Passivity of Metals."

The golf competition for the silver challenge cup presented by the President of the Royal Metal Trades' Pension and Benevolent Society will be held on Wednesday, May 25, at Chipstead. Entries for this event close on Friday, May 20. The entrance fee of 10s. should be sent to the Society at 195, Upper Thames Street, London, E.C.4.

The Council of the Institution of Civil Engineers have recently made the following awards in respect of papers read and discussed at the ordinary meetings during the session 1926-27:—Telford Gold Medals to Mr. I. J. Jones (London) and Mr. T. B. Hunter (London); a Watt Gold Medal to Mr. Gerald Currey (London); and a George Stephenson Gold Medal to Mr. A. L. Bell (Malta); Telford premiums to Mr. A. W. Stonebridge (Bombay); Mr. P. R. Roberts (Barrow-in-Furness); Mr. A. C. Anderson (London) and Mr. George Ellson (London); a Manby premium to Professor Douglas Hay (Sheffield); and a Trevithick premium to Mr. Powys Davies (India).

Thos. W. Ward, Limited, Sheffield, have purchased as a going concern the Meadow Hall Ironworks, Sheffield, of J. Crowley & Company, Limited. The purchase comprises the freehold buildings and land covering 11 acres, malleable and cast iron foundries and engineering shops, and railway sidings having connections with the L.M. & S. and L. & N.E. Railways. The business was established over 100 years ago, has a wide connection and a good reputation, whilst the plant is capable of producing 55 tons of malleable iron castings and 50 tons of light iron castings weekly. Thos. W. Ward, Limited, do not expect to dismantle the works, and hope to make arrangements which will enable the business to be successfully carried on.

At the Empire Mining and Metallurgical Congress, which will be held next August, the Canadian Institute of Mining and Metallurgy intimate that the following papers are definitely arranged for:—"Asbestos Mining and Milling, by J. G. Ross; "Portland Cement in Canada," by W. A. Toohey; "Mining Coal under the Sea, in Nova Scotia, with Notes on Comparable Operations Elsewhere," by F. W. Gray; "The Coal Industry in Western Canada," by Messrs. Robert Strachan, W. J. Dick, and R. J. Lee; "Canadian Copper and its Production," by C. P. Browning; "Impact Resistance of Steel at Low Temperature," by A. E. Cameron; "Smelting Titaniferous Ores of Iron," by A. Stansfield; "The Cascade Method of Pouring Steel," by J. G. Morrow; "Lead and Zinc in Canada," by T. W. Bingay; "Magnesite," by G. M. Carrie; "Nickel, Past and Present," by R. C. Stanley; "Petroleum in Canada," by Messrs. W. A. Bell, R. B. Harkness, G. S. Hume, O. B. Hopkins and S. J. Cook (with an introduction by John Ness). Contributions from institutions overseas will probably include:—The Institution of Mining Engineers: A Paper on Health Safety Problems. The Institution of Mining and Metallurgy: A Paper on the Empire Question, by Sir Thos. Holland. The Iron and Steel Institute will probably contribute one or more papers. The Institute of Petroleum Technologists will present one or more papers.

Mr. R. L. McLellan, formerly managing director of Cia. Westinghouse Electric Internacional, S.A., has been appointed general manager of the Westinghouse International Company, with headquarters in New York.

Contracts Open.

Cape Town, June 2.—Electricity meters (Specification 381/1927), for the City of Cape Town Electricity Department. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. B.X. 3,489.)

Dublin, May 25.—Copper, lead, etc., for the Great Southern Railway of Ireland. The Stores Superintendent, General Stores Department, G.S. Railway, Inchicore, Dublin.

Dublin, May 23.—Steam pipes, exhaust pipes, water pipes, circulating water pipes and valves for their proposed new 5,000-kw. turbo-alternator, for the Borough Commissioners. The Electrical Engineer and Manager, Fleet Street, Dublin. (Fee £3 3s., returnable.)

Johannesburg, June 2.—Electricity meters, for the Municipal Council of Johannesburg. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. B.X. 3,487.)

Melbourne, July 13.—One 30-ton electric overhead travelling crane, for the Victorian Government Railways. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 4,625.)

Ramsgate, May 25.—2,800 yards of unclimbable iron fencing and gates, for the Corporation. The Borough Engineer's Office, 2nd Floor, Albion House, Ramsgate.

The Continental Steel Trust.

At the meeting held in the city of Luxemburg, on May 3, attention was devoted to fixing the penalties to be paid by the individual countries for exceeding their allotted production. It was found that Germany, Belgium and Luxemburg had exceeded their quotas in the first quarter of the current year, whereas France produced less than her allotment.

The production of Germany in that quarter totalled 3,958,000 tons (her quota being 3,021,000 tons), France produced 2,005,000 tons (her quota being 2,154,000 tons), Belgium 924,000 tons (quota 815,000), Luxemburg 583,000 tons (quota 577,000 tons), and the Saar area 471,000 tons (quota 402,000 tons). The total production of these countries during the first half of Continental Steel Trust's business year amounted to 15,892,000 tons, exceeding the quota by 1,601,000 tons. Germany had the greatest excess production of 1,511,000 tons, while Belgium produced 222,000 tons more than her quota, and the Saar area exceeded her quota by 107,000 tons. France produced 235,000 tons less than her quota, and Luxemburg produced 4,000 tons less.

Concerning the proposed sale syndicate for semi-finished material joists and shapes, it was finally agreed to accept the export tonnage only as the basis for fixing allotments. The difficulties yet to be overcome in this respect concern the fixing of the period to be taken as the basis for this purpose. As it is desired to take into consideration the exports also during the first three months of the current year, the proceedings were adjourned until June 9, when more ample information is hoped to have become available.

France requested that the production intended for inland consumption should be taken into consideration as well as that for export; but the majority of the Council decided that only the tonnage intended for export was to be considered. It had been suggested to take as a basis for fixing quotas the figures of the first quarter of 1927; unfortunately it was found that the majority of the French members of the Trust had exported during that quarter a tonnage by far superior to former ones; whereupon they proposed successively that 2, 3, 4 and even 5 quarters may be considered as the basis. For the first quarter of 1926, Belgium demanded another increase on the plea that floods and the strike had been a handicap to her production during the first three months of 1926; France also asked for an increase in order to take into account the gradual re-instatement of the war-damaged plants. But no agreement was reached, and the debate had to be put off till June, as already stated.

As reported from Beuthen, in Polish Upper Silesia, the Polish Iron and Steel Syndicate met on May 6, to decide upon the definite conditions to be put forward under which the Polish works would join the Continental Steel Trust, but the discussion did not lead to any decision.

Company Reports.

Coventry Chain Company, Limited.—Interim ordinary dividend, 2 per cent., less tax.

Siemens Bros. & Company, Limited.—Final dividend, 5 per cent., making 7½ per cent. for year, less tax.

Allen-Liversidge, Limited.—Preference dividend, 6½ per cent. per annum (less tax) for six months ended April 30, 1927.

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IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—It is perhaps as yet too early to estimate fully the effect of last week's reduction in Cleveland iron prices, but so far the market has not been so favourably affected as had been anticipated, buyers still maintaining an attitude of indifference, with business almost entirely confined to purchases for immediate requirements. The effect upon export business also has been practically nil, and it is quite clear that there must be further price concessions, if the coastwise trade with Scotland is to be recovered. Meanwhile, accumulations of pig-iron are reported to be showing an upward trend, and in present-day conditions makers are not in a position to carry excessive stocks. Prices remain as follows :—No. 1, 77s. 6d.; No. 3 G.M.B., 75s.; No. 4 foundry, 74s.; No. 4 forge, 73s. 6d. per ton.

The Tees-side market for hematite has developed further weakness, the price of East Coast mixed numbers being no more than 80s. per ton, with No. 1 quality obtainable at 80s. 6d. per ton. On the North-West Coast prices are unchanged, with Bessemer mixed numbers quoted at £4 12s. 6d. per ton delivered at Glasgow, £4 15s. 6d. per ton delivered at Sheffield, and £4 17s. 6d. per ton delivered at Birmingham.

LANCASHIRE.—Consumers of foundry pig in this area are still fairly well covered by old contracts, and consequently new business is merely a question of comparatively small parcels for early delivery. The market is undoubtedly weak, with Cleveland quoted at 88s. 2d., Derbyshire at 88s., Staffordshire at 87s. 6d., and Scottish at 101s. upwards.

THE MIDLANDS.—Owing to keen Continental competition, some furnaces supplying this district have been offering price concessions to secure business. It is reported that some Northants iron has been reduced to between 72s. 6d. and 74s. 6d. at the furnaces, and Derbyshire round about 77s. 6d. to 80s. per ton, while North Staffordshire foundry pig-iron is quoted at 80s. f.o.t.

SCOTLAND.—No. 3 Scotch foundry is now quoted at 83s. at furnaces, but buyers, bearing in mind that the lowest price touched last year was 74s. to 75s., have not much encouragement to make contracts at present rates; hence business continues of a hand-to-mouth nature.

Steel.

The steel market at Sheffield is not in a very optimistic mood at the moment, and business in all classes of semi-products is by no means active. Continental competition is becoming more severe, and the prices quoted for billets as compared with those of local producers appear very expensive. These imported billets, however, are not suited to all Sheffield requirements. The production of open-hearth steel is showing a slight decline in the absence of new business, although the total output is still very large. Crucible steel-makers are benefiting by the fall of about two shillings in the price of patent oven coke. The home tinplate trade seems to be improving a little, although buyers are still proceeding cautiously. For usual lines quotations run about 19s. 3d. basis for coke primes, and 18s. 3d. to 18s. 6d. basis for wasters in basis sizes, net cash, f.o.t. at makers' works.

Scrap.

Business in all the chief markets for scrap metal continues in an unfavourable position, and in Scotland heavy machinery cast-iron scrap is now quoted at 77s. 6d. per ton. Heavy ordinary cast-iron scrap is rather easy around 72s. 6d. per ton, and steelworks cast-iron scrap in furnace sizes 70s. to 71s. 3d. per ton. Light cast-iron scrap has again been done at 57s. 6d. to 58s. 6d. per ton. The above prices are all per ton, delivered f.o.t. consumers' works.

Metals.

Copper.—In the markets for base metals, the outlook as concerns standard copper may be regarded as slightly more satisfactory, values during the past week having appreciated to a small extent, and with the reduction in Metal Exchange warehouse stocks of both refined and rough, the position may become slightly stronger. In fact, in some quarters the outlook is regarded with greater confidence.

Official closing prices of standard copper have been as follow :—

Cash : Thursday, £55 5s. to £55 6s. 3d.; Friday, £55 1s. 3d. to £55 2s. 6d.; Monday, £54 16s. 3d. to £54 17s. 6d.; Tuesday, £54 8s. 9d. to £54 10s.; Wednesday, £54 11s. 3d. to £54 12s. 6d.

Three Months : Thursday, £55 16s. 3d. to £55 17s. 6d.; Friday, £55 12s. 6d. to £55 13s. 9d.; Monday, £55 7s. 6d. to £55 8s. 9d.; Tuesday, £55 1s. 3d. to £55 2s. 6d.; Wednesday, £55 3s. 9d. to £55 5s.

Tin.—A more favourable impression of the statistical position having been formed since the issue of the official figures for April, the market for standard tin has experienced considerable speculative activity, though values at the week-end closed below the best. The American deliveries were excellent, amounting to 6,720 tons, this being the highest monthly return since July last year. Home and Continental deliveries are also satisfactory, but the rather poor state of the Welsh tinplate industry is detrimental to sentiment. Hence market prospects are somewhat obscure.

Official closing prices of standard tin have been as under :—

Cash : Thursday, £295 15s. to £296; Friday, £293 5s. to £293 10s.; Monday, £290 12s. 6d. to £290 17s. 6d.; Tuesday, £290 15s. to £290 17s. 6d.; Wednesday, £292 12s. 6d. to £292 15s.

Three Months : Thursday, £286 10s. to £286 15s.; Friday, £285 2s. 6d. to £285 7s. 6d.; Monday, £283 2s. 6d. to £283 7s. 6d.; Tuesday, £283 5s. to £283 7s. 6d.; Wednesday, £284 15s. to £285.

Spelter.—With a fairly satisfactory demand on home consumptive account, the market for ordinary spelter gives indications of revived interest on the part of buyers, but business is by no means active and values fluctuating. The curtailment of production is beginning to be felt in many ways, and an improvement in prices in the near future seems not unlikely, as prospects are favourable to an expansion of demand.

The following are the week's prices :—

Ordinary : Thursday, £29 6s. 3d.; Friday, £29 5s.; Monday, £29 2s. 6d.; Tuesday, £28 17s. 6d.; Wednesday, £29 1s. 3d.

Lead.—The market for soft foreign pig continues weak, with actual business on a minimum scale. Although some curtailment of output may not be far off, there is no sign at present of any slackening in the rate of shipments, and hence it is impossible to take a very sanguine view of the immediate future.

The week's prices are appended :—

Soft foreign (prompt) : Thursday, £25 7s. 6d.; Friday, £25 8s. 9d.; Monday, £25 2s. 6d.; Tuesday, £24 17s. 6d.; Wednesday, £25.

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